high accuracy for automatically solving color registration problems for image capturing and outputting devices.

Automatic color misregistration removal methods exist for Roman characters.

5 Unfortunately, no automatic solution exist in the known prior art which is intended specifically to solve or enhance misregistration problems with Kanji characters. There is a large market for digital imaging products in Asia, including China, Japan, and Southeast Asia. Kanji or Chinese characters are very important and cannot be ignored if digital imaging products are to be successful in Asia. The difficulty in scanning Kanji characters is that the characters include lines ranging

10 between very broad to very thin. The problem of color misregistration is exacerbated by the very thin portions of these characters. Other alphabets having a combination of very thick and thin lines include Arabic, Hebrew, Greek, and Cryllic, and share this problem.

There are non-Kanji specific proposals to solve color misregistration problem in the known prior art. These general image processing techniques described in prior art to detect color

15 misregistration includes subjective heuristic U.S. Patent No. 4,583,116; approximation, U.S. Patent No. 5,500,746; and truncation techniques U.S. Patent No. 5,907,414. Known prior art techniques generally rely on empirical data to identify color misregistration. The present invention, using 3D color determinant mathematics, is more objective, repeatable, and customizable into a variety of imaging products.

20 Color misregistration detection and correction in the prior art is not an accurate process. For example, in U.S. Patent No. 5,477,35 5,477,335, color misregistration error is found by performing edge detection inside a 5x5 window. In addition, a variety of text structure patterns are compared with image pixels to determine whether the pixel is located at an edge of text. If an

arrangement in which the chromatic aberration of events is separated into a linear component of a magnitude in proportion to the distance H from the optical center, namely, the optical axis into the other non-linear component, and two individual correction waveform corresponding to each of

5      these components are generated. Registration error is corrected by this generated waveform.

U.S. Patent No. 4,953,013, granted August 28, 1990, to Tsuji *et al.*, for *Color image processing device*, describes a method of printing black text where the color fringing is minimized due to CMY Ink balance and alignment. In this patent, the main objectives are to detect the edge of a black character. A variety of edge detection patterns are determined for use in detecting black

10     text.

U.S. Patent No. ~~5,477,35~~ 5,477,335, granted December 19, 1995 to Tai, for *Method and apparatus of copying of black text on documents using a color scanner*, describes a method of detecting misregistration through edge detection and black text detection. A processing pixel is distinguished inside a 5x5 window; edge detection is performed by identify text structure; a black

15     text is identified by finding a neighboring white pixel in the window for background and a high contrast pixel for the current pixel. With the identified high contrast edge area of a black text found, a black color will be output for that pixel with a LAB (100, 0,0).

U.S. Patent No. 5,500,746, granted March 19, 1996, to Aida, for *Color image input apparatus*, describes a technique for correcting color misregistration for digital cameras and

20     scanners in the main scanning direction. Color is shifted plus or minus one dot by averaging or interpolating the difference in the main scanning direction, with correlation coefficients.

U.S. Patent No. 5,555,107, granted September 10,1996, to Funada *et al.*, for *Image processing apparatus for judging a color using spatial frequency corrected color*

abs (R[-1]-R[1] > 80), flatness detection, for identifying text and background. An assumption is

made that a pixel inside a letter image and in the background image is constant *e.g.*

abs (R[-2]-R[-3] ) < 20, and that level detection, R[-2] < R[0]<R[2] || R[-2] < R[0]<R[2]. All of

5      the detector's threshold parameters are predetermined based on subjective and experimental data.

Summary of the Invention

A method for correcting misregistration of scanned thin line character components

includes detecting a misregistered pixel; determining whether the misregistered pixel is part of a

character; applying a three-dimensional color vector determinant to the misregistered pixel; and

10      reducing the chrominance component of the misregistered pixel to provide a corrected pixel.

An object of the invention to introduce a technique which automatically identifies

and corrects color misregistration problems for alphabet characters having thin lines.

Another object of the invention is to provide a method of image analysis using

three-dimensional color vector determinant to identify or ~~classified~~ classify features in an image.

15      This summary and objectives of the invention are provided to enable quick

comprehension of the nature of the invention. A more thorough understanding of the invention

may be obtained by reference to the following detailed description of the preferred embodiment of

the invention in connection with the drawings.

Brief Description of the Drawings

20      Fig. 1 depicts the scanned result of image without the presence of color

misregistration causing color fringing around text.

Fig. 2 depicts the scanned result of image with the presence of color misregistration

causing color fringing around text.

correction through interpolation or smoothing will likely make the situation worse.

The technique of the invention is a method of image analysis using three-dimensional color determinant mathematics. Through the use of the method described

5     herein, the color misregistration problem in Kanji, and similar alphabets, may now be detected and resolved automatically, as it will be apparent after a reading of the following description. Although the techniques described herein may be applicable to a number of alphabets, the description which follows will focus on resolution of scanning problems in the Kanji alphabet. While it is an additional object of present invention to disclose a new method of image analysis

10    using three-dimensional color vector determinant to identify or ~~classified~~ <u>classify</u> features in an image, and while 3D color vector determinant method may easily be applied to other fields and applications, such as segmentation, compression, and pattern recognition, the applications of 3D determinant mathematics for the analysis of image content into these and other fields are beyond the scope of the present disclosure.

15    This invention, using three-dimensional color vector determinant mathematics, enables a rapid detection of misregistration in Kanji. The total processing cost for text and misregistration detection is only two multiplications, three additions, and one comparison, making this invention very competitive both in speed and cost.

The techniques described in U.S. Patent No. 5,907,414, or the one proposed in the

20    above-identified related application, are state of the art interpolation and information recovery techniques, which work well for Roman characters, but which actually may degrade image quality when applied to scanned thin line portions of a Kanji character.

Figs. 1 and 2 depict scanned images which are uncorrected and corrected by the